Tutorial on advanced magneto-optic based instrumentation: From vectorial-resolved MOKE to element-resolved magnetic holography imaging

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Magneto-optic based techniques are widely applied in Nanomagnetism research because of its high sensitivity (down to nanometer thickness), time resolution (down to picosecond regime), vanishing substrate effects (limited penetration depth), and immunity to external fields (photon-in/photon-out approach). Dimensionality, magnetic symmetry, and/or interfacial effects promote much of the new properties observed in complex multilayered magnetic nanostructures. Current and future technologies require the control of those and the microscopic understanding of their emerging phenomena in order to can tailor novel devices based on magnetic nanostructures.

In this tutorial I will introduce the basics of magneto-optic phenomena exploited in advanced instrumentation. First, I will introduce the capabilities of a high resolution vectorial Kerr magnetomer [1,2] with angular, vectorial, temperature, and time resolutions, which required a relatively simple experimental implementation. Second, ultimate synchrotron-based techniques will be introduced,[3,4] including resonant magnetic scattering holography imaging, which provide in addition the element selectivity required in order to disentangle the magnetic behaviour of multicomponent nanostructures. I will illustrate their capabilities with studies performed in model spintronic magnetic nanostructures, including ferromagnetic thin films, exchange-biased bilayer systems, and trilayers systems (i.e., spin-valves and magnetic tunnel junctions). In brief, the data show the strong influence of the magnetic symmetry, dimensionality, and artificial interfaces on the properties of magnetic nanostructures, and provide the keys to control them. These fundamental understandings could be applicable to tailor the behaviour of magnetic nanostructures and, thus, to be the first step towards developing of devices with custom-chosen properties.

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